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Clinical Study

Rates of osteoporosis screening and treatment following vertebral fracture

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Abstract

BACKGROUND CONTEXT: Osteoporosis remains an underrecognized and undertreated disease entity in the orthopaedic setting, accounting for substantial long-term morbidity and mortality. Osteoporosis is often not diagnosed or treated until multiple fractures have occurred. Vertebral compression fractures are the most common sentinel fracture, providing an opportunity to intervene with antiresorptive therapy before more debilitating fractures occur. Little data has been published on osteoporosis screening and treatment following vertebral fractures. Further elucidation of the osteoporosis care gap in these patients is warranted.
PURPOSE: To demonstrate the current state of post vertebral fracture osteoporosis management at a large tertiary care center with no established secondary fracture prevention program.
STUDY DESIGN: Retrospective cohort study.
SETTING: A large tertiary care hospital or one of its affiliated community hospitals.
PATIENT SAMPLE: All 2,933 patients, 50 years of age or older, who presented to an emergency department with a new vertebral fracture between 2008 and 2014.
OUTCOME MEASURES: The physiological measures are rates of new fractures within 2 years following first vertebral fracture.
PATIENT CARE METRICS: Post vertebral fracture rates of dual energy X-ray absorptiometry (DXA) testing, calcium and vitamin D supplementation, and pharmacotherapy for osteoporosis within 1 year postfracture, and more than 1 year postfracture. Linear trend of the rate of new antiosteoporosis pharmacotherapy among previously antiosteoporosis medication naive patients within 1 year of fracture over time from 2008 to 2014.
METHODS: All patients aged 50 years or older presenting to an emergency department with a vertebral fracture between 2008 and 2014 were included. Only an individual's first documented vertebral fracture was considered. Individuals were assessed for DXA screening, calcium and vitamin D supplementation, treatment with an antiosteoporosis medication, and additional fractures following incident vertebral fracture. Statistical analyses included descriptive statistics and a simple logistic regression. No specific funding was provided for this study. The authors of this study report no relevant financial conflicts of interests or associated biases.
RESULTS: Between 2008 and 2014, 2,933 unique patients were seen at an included emergency department for one or more vertebral fracture encounters. Ninety-eight percent did not receive a DXA scan within the preceding 2 years or 1 year following fracture. Seven percent of patients were started on antiresorptive therapy after their fracture, with 341 (5%) starting within 1 year of fracture and 211 (2%) starting thereafter. Twenty-one percent (n=616) had taken an antiresorptive medication before their fracture. Seventy three percent (n=2,128) were never prescribed antiresorptive therapy. Treatment rates slightly decreased over time. Thirty eight percent of patients presenting with a vertebral fracture (n=1,115) went on to develop a second fragility fracture within 2 years.

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CONCLUSIONS: In the absence of a specific local program to improve secondary fracture prevention following minimal trauma spinal fractures, recognition and treatment of osteoporosis in patients at this institution remained dismal over time despite numerous calls to action on the topic in the orthopaedic literature and elsewhere. Undertreatment of osteoporosis puts patients at increased risk of incurring additional fractures. Within 2 years, 38% of the patients in this sample developed an additional fragility fracture. This study demonstrates a profound post vertebral fracture osteoporosis care gap.

Keywords: Osteoporosis; Vertebral fracture; Fragility fracture; Fracture prevention; Fracture liaison service; FLS; osteopenia; refracture

Introduction

Osteoporosis remains an under recognized and undertreated disease entity in the orthopaedic setting, accounting for substantial long term morbidity and mortality. One in two women and one in five men will have a fragility fracture at some point in their lives [1]. Vertebral fractures are the most common type of fragility fracture. According to epidemiological data used in developing the United States Fracture Risk Assessment Tool, vertebral fractures account for 27% of the two million annual fragility fractures in the US [2]. That rate may be an underestimate, as a recent study conducted in the UK found radiologists missed more than 50% of incidental vertebral fractures [3]. Having any fragility fracture doubles the risk of future fragility fractures, whereas having a vertebral fracture increases the risk of future vertebral fractures four-fold [4]. Osteoporosis is often not diagnosed or treated until multiple fractures have occurred. Vertebral compression fractures are the most common sentinel fracture, providing an opportunity to intervene with antiresorptive therapy before more debilitating fractures occur.

Antiresorptive medications reduce the rate of new fractures and improve pain in symptomatic vertebral fracture patients. The American Academy of Orthopaedic Surgeons recommends calcitonin treatment of symptomatic vertebral fractures [5]. The Food and Drug Administration-approved medications have been shown to, on an average, reduce the risk of future nonvertebral fractures by approximately 50% and future vertebral fractures by approximately 70% [6]. Despite the efficacy of available medications, there is widespread international consensus that real world recognition and management of osteoporosis is suboptimal [7–9].

The US Medicare data indicate the majority of women aged 65 to 85 who sustain a fracture are neither evaluated nor treated for osteoporosis in the year following fracture [10]. This rate has improved somewhat over time, but in 2015, the last year for which data are available, approximately 60% of these women were not screened or treated for osteoporosis. The improvement in this rate over time is likely caused by the increasing adoption of institutional efforts to address this post fracture osteoporosis care gap.

The most popular form of such efforts is a fracture liaison service (FLS). The FLS programs generally consist of one or more healthcare professionals who screen fracture patients for osteoporosis and initiate osteoporosis treatment when indicated. These programs have been shown to improve treatment rates and reduce the rate of new fractures. Campaigns such as the American Orthopaedic Association's Own the Bone have helped drive the increasing adoption of the FLS model throughout the US. Despite the increasing adoption of these programs, most fracture patients in the population with the highest risk of osteoporosis are still not being screened or treated for osteoporosis.

Although, this persistent care gap may be due in part to the slow process of implementing FLS programs, it may also be due in part to a lack of understanding of the true magnitude of the care gap at institutions without such programs. To date, no large studies in the United States have examined the magnitude of the osteoporosis care gap following vertebral fracture at an institution without a systematic approach to managing these patients.

Freedman et al. come close to addressing this knowledge gap, but their study has limited generalizability because it was conducted in a retired military population and because more than 30% of their vertebral fracture patients were seen by an endocrinologist [11]. These endocrinology referrals appear to have been triggered by the fracture and thus represent a significant, if incomplete, systematic effort to address the postfracture osteoporosis care gap. The rates of dual energy X-ray absorptiometry (DXA) scanning and treatment in their cohort closely parallel this referral rate, suggesting they may represent the results of this invention rather than a true baseline for the population at large.

More realistic baselines can be seen in the pre-FLS implementation figures from other countries. In a cohort study comparing pre-FLS to post-FLS screening and treatment rates following any fragility fracture at a large Swedish hospital, Axelsson et al. found only 8% of the patients received a DXA scan and only 13% received a prescription for an osteoporosis medication in the year following fracture before the FLS was implemented [12]. These rates increased to 40% and 32% respectively following FLS implementation. No data were reported on vertebral fractures specifically. A few similar studies have been published, most of which have either included vertebral fractures with other fragility fractures

or specifically excluded them [12–14]. As such, relatively little has been published on secondary prevention efforts following vertebral fracture. Limited data is available on the rates of osteoporosis screening and treatment following vertebral fractures in the United States at institutions lacking established secondary prevention efforts, such as FLS programs. The present study aims to address that gap.

Methods

The primary objective of this research was to demonstrate the current state of post vertebral fracture osteoporosis management in routine clinical practice at a large tertiary care center with no established secondary fracture prevention program. A retrospective cohort review was performed on data extracted retrospectively from the electronic medical records of all patients seen for an incident vertebral fracture at an emergency department of a large, level 1 trauma center or one of its six affiliated community hospitals. Both the primary medical record and the pharmacy record were queried for all patients who presented to any included emergency room with any fracture after their 50th birthday. Those records were then cross-linked and then integrated into a single investigator managed dataset using the patient's medical record number to match patients' medical and pharmacy records. The medical records system from which data was retrieved then contained both inpatient and outpatient records for the entire health system covering a 7 year period and more than 1,000 physicians as well as the majority of DXA scanners within a 2 hour radius at all timepoints studied.

Incident vertebral fractures were defined as an emergency room visit that included an ICD 9 code starting with 805 or 806 as a diagnosis code for the visit. Only an individual's first recorded vertebral fracture visit was counted as an incident vertebral fracture. Incident vertebral fractures were included if they were recorded between July 2008, when the current electronic medical record system was implemented, to September 2014, exactly 2 years before the implementation of ICD 10 coding at this institution. The 2 year lag period was included to allow assessment of all follow up measures with consistent coding.

The relative frequency of high energy mechanisms of injury within this database were assessed using two methods. First, ICD 9 codes for high energy mechanisms, such as gunshot wounds, and car accidents, were examined. The frequency of high energy mechanisms was also assessed indirectly by determining the frequency of additional fractures recorded at the emergency department visit for the incident vertebral fracture. Rib fractures were analyzed separately because of their relative prevalence and because they could plausibly represent incidental injuries obtained during a fall from standing or through another low energy mechanism.

To quantify osteoporosis screening in individuals presenting with incident vertebral fractures, rates of DXA scanning were assessed at several timepoints relative to fracture. All DXA scan results were pulled from the system for individuals with incident vertebral fractures based on medical record numbers. Time from DXA scan to incident vertebral fracture was assessed with a time lapsed variable. The DXA scans completed within 2 years, before incident fracture were included, as these were considered a valid basis for initiating new treatment. The DXA scans within 1 year following fracture among individuals without a DXA scan in the prior 2 years were likewise counted, as these potentially represented screening that could be used to initiate treatment post fracture.

Treatment rates were assessed by measuring the rate of prescribing of FDA approved medications for osteoporosis both before and after fracture. The FDA approved medications at the time of this article included: bisphosphonates, teriparatide, denosumab, raloxifene, and calcitonin. Any prior prescription of any of these FDA approved medications was counted as a patient who had received prior treatment for osteoporosis. Individuals who had not previously received a prescription for one of these medications were considered treatment naïve for osteoporosis. Delayed treatment was assessed by counting individuals who were first prescribed an osteoporosis medication more than 1 year following their incident vertebral fracture.

To assess whether treatment rates improved over time among treatment naïve incident vertebral fracture patients, patients were subdivided by the year of their incident fracture and the rate of new treatment among treatment naïve individuals within these annual cohorts was calculated. Simple logistic regression was used to test for statistically significant trends in this rate over time.

Rates of calcium and vitamin D supplementation were assessed both before and after fracture. An individual's first recorded prescription for both calcium and vitamin D supplementation was recorded and compared with their incident fracture date to determine the timing of starting supplementation relative to fracture.

A composite measure of treatment with either FDA approved medications or calcium and vitamin D supplementation was calculated by looking at the percentage of patients with treatment with either group of treatments before fracture, within 1 year post fracture, and greater than 1 year post fracture. These time intervals were mutually exclusive, as in the prior variables.

The rate of new fractures within 2 years of incident vertebral fracture (refracture) was assessed by counting the number of new emergency department visits for vertebral (ICD 9: 805 or 806), hip (ICD 9: 820), femur (ICD 9: 821), forearm (ICD 9: 813), humerus (ICD 9: 812), wrist (ICD 9: 814), pelvis (ICD 9: 808), patella (ICD 9: 822), and ankle (ICD 9: 824) fractures within 730 days of that patient's incident vertebral fracture. The list of eligible fracture types was derived by truncating ICD 9 fracture codes from a joint

commission list of potentially osteoporotic fractures. To avoid counting additional visits to the emergency department for incident vertebral fracture, new emergency department visits for vertebral fractures were not counted as new fractures until 91 days after incident vertebral fracture. This 90 day exclusion period was based on the anticipated healing time for vertebral fractures. Refracture categories are not mutually exclusive, as some individuals had more than one additional fracture.

All analyses were conducted in R Studio version Version 1.0.153 (RStudio, Inc., Boston, MA).

The authors of this study report no relevant financial conflicts of interests. This study received no specific funding.

Results

Between July 2008 and September 2014, 2,933 unique individuals presented to an included emergency department with an incident vertebral fracture on or after their 50th birthday. Mean age at fracture was 73.8 years old (SD 13.1). Sixty percent (59.7%) of subjects were female with the remainder male. Ninety-five percent (94.6%) of patients were white, 4.4% black and less than 1% were Asian, Hispanic, Other, or Unknown.

In the complete data set of emergency department fractures in individuals age 50 or older (N=36,369 fractures), specific ICD 9 codes for high energy trauma mechanisms were reported for 58 patients, of which 0 were associated with a vertebral fracture. During the same visit as the incident fracture, 192 or 6.5% of patients had one or more other documented fractures. Fifty-two or 1.8% included only one or more rib fractures. When rib fractures were excluded, 4.8% had one or more nonrib fractures during their emergency department visit for the incident vertebral fracture. When rib fractures were excluded, the distribution of fracture types was similar to the distribution of fractures in this population generally.

Data on DXA scanning rates are presented in Fig. 1. Forty-six patients (1.5%) received a DXA scan in the 2 year period before their incident fracture. Seventeen patients, 0.6% of the remaining patients, received a DXA scan in the year following fracture. Twenty-four (0.8% of previously unscanned patients) had their first DXA scan more than 1 year after fracture.

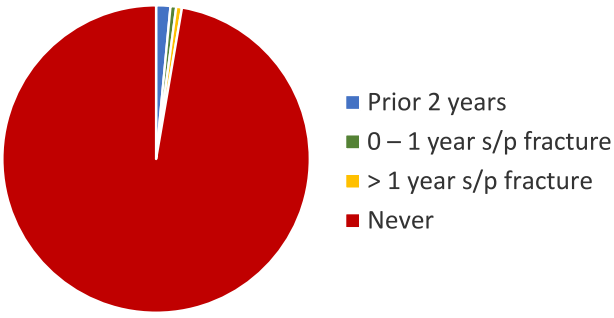

Fig. 1. The DXA scanning rates. The incidence of dual energy X-ray absorptiometry scanning at various timepoints relative to the incident vertebral fracture with each individual counted only in the first time period for which they qualify. S/p represents status post.

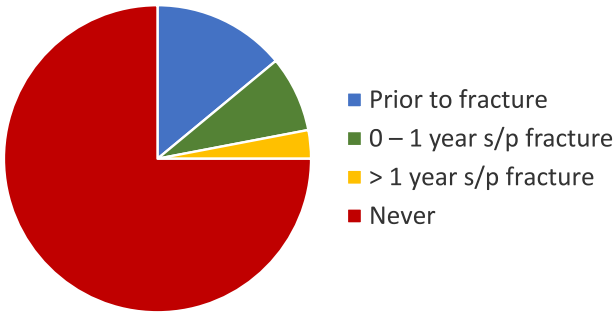

Fig. 2. Rate of calcium and vitamin D supplementation. The distribution of documented start times of calcium and vitamin D supplementation relative to the incident vertebral fracture. Individuals were classified based on whether they received their first documented calcium and vitamin D supplementation before the fracture, within the first year following fracture, more than one year following fracture, or at no time in the available records.

Data on calcium and vitamin D supplementation rates are presented in Fig. 2. Four hundred patients (14%) were documented as taking calcium and vitamin D supplementation before their incident vertebral fracture. Of those with no prior supplementation, 230 started supplementation in the year following fracture. Of those with no supplementation by 1 year postfracture, 85 started supplementation at some subsequent time in the available records.

Data on rates of either pharmacotherapy with an FDA approved medication for osteoporosis or calcium and vitamin D supplementation are presented in Fig. 3. Seven hundred seventy-eight patients (27%) were on either pharmacotherapy with an FDA approved medication for osteoporosis or calcium and vitamin D supplementation

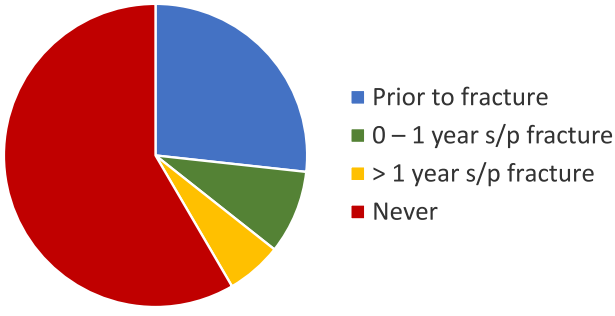

Fig. 3. Rate of antiosteoporosis pharmacotherapy or calcium and vitamin D supplementation. The distribution of documented start times of either antiosteoporosis pharmacotherapy or calcium and vitamin D supplementation relative to the incident vertebral fracture. Individuals were classified based on whether they received their first documented treatment with an FDA approved medication for osteoporosis or calcium and vitamin D supplementation before the fracture, within the first year following fracture, more than one year following fracture, or at no time in the available records. FDA, food and drug administration.

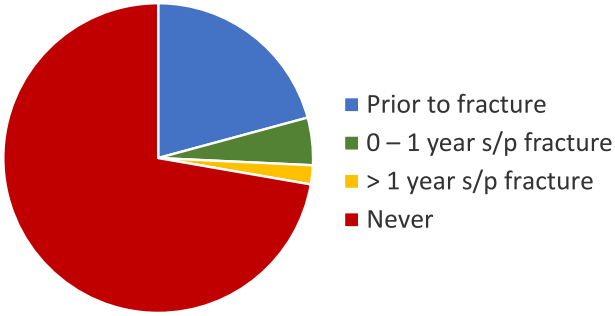

Fig. 4. Rate of pharmacotherapy with an FDA approved medication for osteoporosis. The distribution of documented start times of antiosteoporosis pharmacotherapy using a medication approved by the FDA for osteoporosis relative to the incident vertebral fracture. Individuals were classified based on whether they received their first documented treatment with an FDA approved medication before the fracture, within the first year following fracture, more than one year following fracture, or at no time in the available records. FDA, food and drug administration.

before their incident vertebral fracture. Of those with no prior prescription or supplementation, 259 received supplementation or a prescription in the year following fracture. Of those with no supplementation or prescription by 1 year postfracture, 169 received supplementation or a prescription at some subsequent time in the available records.

Data on rates of pharmacotherapy with an FDA approved medication for osteoporosis are presented in Fig. 4. Six hundred sixteen patients (21%) had been prescribed an FDA-approved medication for osteoporosis before their incident vertebral fracture. Of those with no prior prescription, 341 received a prescription for an osteoporosis medication in the year following fracture. Of those with no prescription by 1 year postfracture, 211 received a prescription for osteoporosis at some subsequent time in the available records.

Fig. 5 and Table 1 show the rate of treatment with FDA approved medications for osteoporosis among treatment naïve individuals during the year following fracture over time. Logistic regression found a 1.2% (p=.02) decrease per

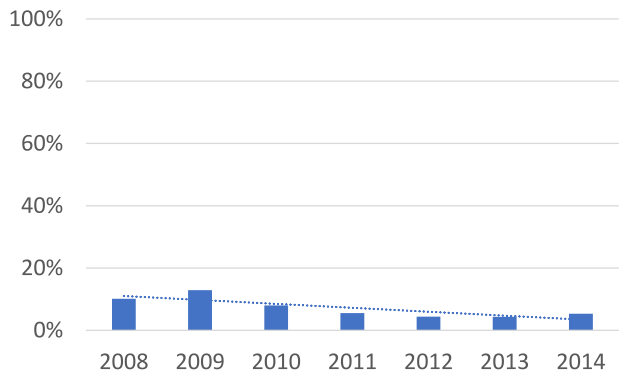

Fig. 5. Treatment rate in previously untreated patients over time. The percentage of treatment naïve patients each year with an initial vertebral fracture who received a prescription for a medication approved by the FDA for osteoporosis. Data is only available for part of 2008 and 2014. FDA, food and drug administration.

Table 1
Treatment rate in previously untreated patients over time

	2008	2009	2010	2011	2012	2013	2014
Total treatment naïve patients	79	225	352	415	459	487	300
Received a new prescription (#)	8	29	28	23	20	21	16
Received a new prescription (%)	10%	13%	8%	6%	4%	4%	5%

Note: This Table depicts the number of treatment naïve patients per year over time, the number who received a prescription for an FDA approved medication for osteoporosis, and the percentage of treatment naïve patients who received a prescription. Data is only available for part of 2008 and 2014.

year in the rate of treatment among previously treatment naïve patients at 1 year post fracture.

One thousand one hundred fifteen patients or 38% of incident vertebral fracture patients went on to develop another osteoporotic fracture within 2 years of their incident vertebral fracture. Table 2 shows the relative frequency of different fracture types among individuals who refractured. The majority of refracture patients (74%) had one or more new vertebral fractures whereas 14% went on to develop a hip or femur fracture.

Discussion

The results of this study indicate osteoporosis recognition and management following vertebral fractures at this large level 1 trauma center and its affiliated community hospitals were grossly inadequate before the establishment of its FLS. More than 90% of vertebral fracture patients did not receive either a formal evaluation for osteoporosis using a DXA scan (0.6%) or empiric treatment with an FDA

Table 2
Refracture counts 2 years post vertebral fracture

Fracture type	n	%
Vertebral*	844	30.6%
Hip	130	4.7%
Pelvis	128	4.6%
Radius/ulna	101	3.7%
Humerus	94	3.4%
Ankle	35	1.3%
Femur	34	1.2%
Patella	8	0.3%

Note: This Table presents data on the incidence of new fractures within 2 years of an incident vertebral fracture by location. The 1,374 fractures were observed in 1,115 of 2,933 patients. The 1,643 patients did not have a fracture. Categories are not mutually exclusive as some individuals had more than one fracture. Fracture types that are not generally considered osteoporotic, such as carpal and rib fractures, were excluded. Displayed percentages represent percentages of patients who had an incident vertebral fracture.

* New vertebral fracture visits occurring within 90 days of the incident vertebral fracture were excluded as potentially relating to the original fracture rather than a new fracture.

approved osteoporosis medication (6%) within the year following their fracture.

The demographic breakdown may raise concerns with some readers about the representativeness of this patient cohort. The gender ratio of six females to four males observed in this study is consistent with prior literature showing a more equal gender balance for vertebral fractures relative to other osteoporotic fracture types [11,15,16]. The Caucasian heavy ethnic makeup is consistent with the slight predilection of Caucasians for osteoporotic fractures superimposed on the heavily Caucasian demographics of the health system's catchment area.

The lack of mechanism of injury coding in the emergency department for any vertebral fracture patients despite the existence of clear ICD 9 modifiers to indicate injury mechanism and the inevitability that some of the 2,933 vertebral fracture patients described here must have had traumatic mechanisms, demonstrates how imperfect data entry during the original patient encounter can limit retrospective analyses based on the extracted data. Although the analysis of the rate of additional fractures diagnosed during the same encounter suggests approximately 5% of vertebral fracture patients may have had a significant mechanism of injury, it is unclear whether this may over- or underestimate the true rate of high energy mechanisms. Regardless, in this age group a significant portion of even high energy fractures are related to osteopenia or osteoporosis.

When patients who had a DXA scan within the 2 years preceding fracture and those who received one in the year following fracture were included, only 63 (2.1%) of patients had a DXA scan that could be used in planning treatment for osteoporosis during the first year following fracture. According to the World Health Organization's definition, osteoporosis can only be diagnosed based on the results of a DXA scan. In 2014, the National Bone Health Alliance suggested that osteoporosis guidelines be changed to allow diagnosis based solely on the presence of characteristic fracture patterns, including vertebral compression fractures, but their suggestion has not yet been widely accepted [17]. Thus, the low rate of DXA scanning in this population despite institutional control of most local DXA scanners suggests nearly 98% of patients presenting with a vertebral fracture did not receive an appropriate work up for osteoporosis.

According to the available records, 2,209 patients or 75% of those who had an incident vertebral fracture never received calcium and vitamin D supplementation at any timepoint in the study period. The data on calcium and vitamin D supplementation should be interpreted with caution, however, as vitamin supplementation may commonly be omitted from patients' medication lists and only supplements included on those lists were retrievable for this study. Calcium and vitamin D supplementation have a role in osteoporosis treatment in individuals who are deficient in them. Because of the high prevalence of deficiency, ensuring adequate calcium and vitamin D intake, whether through diet or supplementation is often considered the first step in osteoporosis management. Given the high prevalence of vitamin D deficiency is the US [18], the low rate of supplementation observed in this sample suggests even the most conservative osteoporosis management steps are frequently being missed in this patient population.

When treatment is defined broadly to include either calcium and vitamin D supplementation or pharmacotherapy with an FDA approved medication, 1,727 patients or 59% of those who had an incident vertebral fracture were never treated. However, because calcium and vitamin D supplementation are only effective in individuals who are deficient, the best indicator of efficacious treatment is the rate of treatment with an FDA approved medication specifically. When only FDA approved medications for osteoporosis were counted, 2,128 patients or 73% of those who had an incident vertebral fracture never received treatment and only 6% of treatment naïve patients were started on treatment in the year following fracture.

The observed decrease in the rate of osteoporosis treatment among treatment naïve fracture patients indicates physicians at this institution did not succeed in correcting the postfracture osteoporosis care gap in the absence of a systematic effort to address that gap. This result is discouraging considering the increasing public focus on bone health during this time, especially post fracture [19–22]. This time period included the latter half of the President's Decade on Bone Health in the United States [19], which ran from 2002 to 2011. Several awareness campaigns have aimed specifically to improve the recognition and management of osteoporosis postfracture [20–22]. These data do not demonstrate a spontaneous improvement in the treatment rates of osteoporosis postfracture corresponding with the increasing activity of such campaigns, as might be expected. Instead, a subtle decline is evident. This trend has been noticed in the literature more broadly and attributed to increased fears over rare side effects of bisphosphonate therapy, such as atypical femur fractures and osteonecrosis of the jaw [23,24].

The 38% rate of new fractures within 2 years of the incident vertebral fracture within this under treated population demonstrates the importance of initiating osteoporosis treatment postfracture to limit subsequent fracture risk. Systematic interventions, such as FLS, have been shown to improve the rate of treatment postfracture and thereby reduce the risk of future fractures.

The results reported here are limited by the nature of the database utilized, which included only providers from a single health system. Although that health system is not the only provider in the area, it is the only tertiary care system for over 2 hours in any direction and contained most local primary care providers and local DXA scanners throughout the study period. Out of a concern over the possibility of incomplete data capture, the lead author discussed the results of this study with members of the local

endocrinology, family medicine, and internal medicine faculty who almost universally thought these results accurately reflected local practice patterns. Many commented that they "did not have time" to evaluate patients for osteoporosis or treat them, even after fractures. In fact, since the establishment of the FLS at this institution, more referrals to the FLS have come from these medical specialties than from surgeons.

Conclusions

This study demonstrates a persistent, profound post vertebral fracture osteoporosis care gap. Most patients were neither screened nor treated for osteoporosis after a vertebral fracture, the rate of treatment among previously untreated individuals worsened over time, and 38% of patients then went on to have another fracture within 2 years. In the absence of a specific local program to improve secondary fracture prevention treatment rates worsened over time. This treatment gap should inspire spine surgeons to reduce the rate of new osteoporotic fractures in their patients by screening and treating them for osteoporotic fractures following vertebral fractures.

Acknowledgment

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References

[1] Lippuner K, Johansson H, Kanis JA, Rizzoli R. Remaining lifetime and absolute 10-year probabilities of osteoporotic fracture in swiss men and women. Osteoporos Int 2009;20(7):1131–40.
[2] Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the united states, 2005-2025. J Bone Miner Res 2007;22 (3):465–75.
[3] Mitchell RM, Jewell P, Javaid MK, McKean D, Ostlere SJ. Reporting of vertebral fragility fractures: Can radiologists help reduce the number of hip fractures. Arch Osteoporos 2017;12(1):71.
[4] Klotzbuecher CM, Ross PD, Landsman PB, Abbott TA, 3rd M Berger. Patients with prior fractures have an increased risk of future fractures: A summary of the literature and statistical synthesis. J Bone Miner Res 2000;15(4):721–39.
[5] Esses SI, McGuire R, Jenkins J, Finkelstein J, Woodard E, Watters WC, 3rd, et al. The treatment of symptomatic osteoporotic spinal compression fractures, J Am Acad Orthop Surg 2011;19:176−82.
[6] Crandall CJ, Newberry SJ, Diamant A, Lim YW, Gellad WF, Booth MJ, et al. Comparative effectiveness of pharmacologic treatments to prevent fractures: An updated systematic review. Ann Intern Med 2014;161(10):711–23.
[7] Jeray KJ, Swiontkowski M. Osteoporosis and fragility fractures: What progress have we made. J Bone Joint Surg Am 2015;97(19):1553–4.
[8] Dell R, Greene D, Schelkun SR, Williams K. Osteoporosis disease management: The role of the orthopaedic surgeon. Journal of Bone and Joint Surgery-American Volume 2008;90A:188–94.
[9] Eekman DA, van Helden SH, Huisman AM, Verhaar HJ, Bultink IE, Geusens PP, et al. Optimizing fracture prevention: The fracture liaison service, an observational study. Osteoporos Int 2014;25(2):701–9.
[10] NCQA. Osteoporosis testing and management in older women. National Center for Quality Assurance 2017.
[11] Freedman BA, Potter BK, Nesti LJ, Giuliani JR, Hampton C, Kuklo TR. Osteoporosis and vertebral compression fractures;continued missed opportunities. The Spine Journal 2008;8(5):756–62.
[12] Axelsson KF, Jacobsson R, Lund D, Lorentzon M. Effectiveness of a minimal resource fracture liaison service. Osteoporos Int 2016;27:3165–75.
[13] Huntjens KM, van Geel TC, Geusens PP, Winkens B, Willems P, van den Bergh J, et al. Impact of guideline implementation by a fracture nurse on subsequent fractures and mortality in patients presenting with non-vertebral fractures. Injury 2011;42(Suppl 4):S39–43.
[14] Huntjens KM, van Geel TA, van den Bergh JP, van Helden S, Willems P, Winkens B, et al. Fracture liaison service: Impact on subsequent nonvertebral fracture incidence and mortality. J Bone Joint Surg Am 2014;96(4):e29.
[15] O'Neill TW, Felsenberg D, Varlow J, Cooper C, Kanis JA, Silman AJ. The prevalence of vertebral deformity in european men and women: The european vertebral osteoporosis study. J Bone Miner Res 1996;11(7):1010–8.
[16] Felsenberg D, Silman AJ, Lunt M, Armbrecht G, Ismail AA, Finn JD, et al. Incidence of vertebral fracture in europe: Results from the european prospective osteoporosis study (epos). J Bone Miner Res 2002;17(4):716–24.
[17] Siris ES, Adler R, Bilezikian J, Bolognese M, Dawson-Hughes B, Favus MJ, et al. The clinical diagnosis of osteoporosis: A position statement from the national bone health alliance working group. Osteoporosis International 2014;25(5):1439–43.
[18] Forrest KY, Stuhldreher WL. Prevalence and correlates of vitamin d deficiency in us adults. Nutr Res 2011;31(1):48–54.
[19] Bone health and osteoporosis. A report of the surgeon general 2004.
[20] 2 million 2 many. National Bone Health Alliance; [2/27/2018]; Available from: http://www.2million2many.org/.
[21] AOA. Own the bone. AOA; [2/27/2018]; Available from: http://www.ownthebone.org/.
[22] Eisman JA, Bogoch ER, Dell R, Harrington JT, McKinney Jr RE, McLellan A, et al. Making the first fracture the last fracture: Asbmr task force report on secondary fracture prevention. J Bone Miner Res 2012;27(10):2039–46.
[23] Khosla S, Shane E. A crisis in the treatment of osteoporosis. J Bone Miner Res 2016;31(8):1485–7.
[24] Roux C, Briot K. Addressing the crisis in the treatment of osteoporosis. Nature Reviews Rheumatology 2018;14:67.